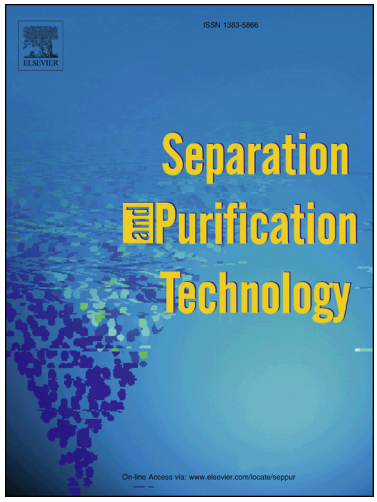

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Fast Extraction and Enrichment of Rare Earth Elements from Waste Water via Microfluidic-Based Hollow Droplet

Zhuo Chen, Wen-Ting Wang, Fu-Ning Sang, Jian-Hong Xu* , Guang-Sheng Luo, and Yun-Dong Wang*

The State Key Laboratory of Chemical Engineering, Department of Chemical Engineering, Tsinghua University, Beijing 100084, China

1

Abstract: The conventional solvent extraction set-up for low-concentration rare earth elements (REEs) at high phase ratios has shortcomings including large factories, long mixing times, high energy consumption, extractant loss and easy emulsification. In this work, a solvent extraction system for Nd(III) using 2-ethylhexyl phosphoric acid-2-ethylhexyl ester (P507) was investigated to enhance extraction in a microfluidic device to solve the above problems. The effects of residence time and phase ratio on the extraction efficiency of a liquid-liquid system were studied. The results showed that extraction efficiency increased as the residence time increased significantly, and a longer channel was required to reach equilibrium for higher phase ratios than for others owing to the decreased oil flow rate and increased mass transfer distance. We also investigated the effects of outlet length, phase ratio, and gas flow rate on the extraction efficiency of a gas-liquid-liquid system. The results indicated that only 0.3 m of the outlet channel was required to reach equilibrium for the entire process, and the overall volume mass transfer coefficient $k_L a$ was 5–50 times larger than in systems without a gas phase.

* Corresponding author: xujianhong@tsinghua.edu.cn; wangyd@mail.tsinghua.edu.cn

ABBREVIATIONS: REEs, rare earth elements; BCF, bioaccumulation factor; CNC, computerized numerical control; CTAB, cetyltrimethyl ammonium bromide; G/O/W, gas-in-oil-in-water; P507, 2-ethylhexyl phosphoric acid-2-ethylhexyl ester; PMMA, polymethyl methacrylate; P-PVB, polyvinyl alcohol phosphate ester; PTFE, polytetrafluoroethylene; UV, ultraviolet